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J. W. LOWELL

DESIGN OF A REINFORCED CONCRETE BUILDING

27p-

DESIGN
# of a
REINFORCED CONCRETE BUILDING

by

JOHN WESLEY LOWELL Jr

A Thesis Submitted for the Degree

of

BACHELOR OF SCIENCE

Civil Engineering Course

UNIVERSITY OF WISCONSIN

1911

TABLE OF CONTENTS.

INTRODUCTION

PART I.

Assumptions ------------------ 1

PART II. BUILDING DESIGN.

Guide------------------------- 4

Theory and allowable stresses- 4

Diagrams used----------------- 5

Notation---------------------- 6

Beam Formulae----------------- 8

DESIGN

Third Floor-------------------10

Footings----------------------17

Basement retaining walls------23

Side Walk---------------------24

Stairways---------------------27

APPENDIX.

Building proposals and specifications.

INTRODUCTION

The University of Wisconsin offers to engineering students exceedingly good courses in Mechanics and Reinforced Concrete Design. When the student has graduated and taken up his profession as an Engineer he will be called upon to put to practical usage the knowledge he has gained while at College. This is one of the most difficult problems he will ever have to solve. His ability as an engineer will be governed by the readiness with which he can apply the theory he has learned, to the practical problems confronting him throughout his professional career.

The greatest difficulty which professional engineers find with the method of teaching in engineering colleges is that theory is not assembled on a practical working basis. That is, when a student graduates the theory he has been taught is lodged in his memory as scattered bits of information. In a short time after graduation, if the man does not apply and thereby classify it, it will soon become lost.

There are many students who upon graduation take up the building profession. These men have to, at first, take very minor positions because they know absolutely nothing about buildings or the parts that make up a building.

There should be offered at the College of Engineering a course in "Architectural Engineering" which would assemble on a practical working basis the knowledge gained in mechanics and reinforced concrete. To the student intending to follow the building profession this course would be of infinite benefit. He would become acquainted with the units which make up a building, what stresses they carry, and how they are designed. He would learn the requirements of the building codes of the most advanced cities of this country, and the practice of the best engineers in this profession. There are many other advantages thus gained, all of great practical benefit; and most of all he would have confidence in his ability if called upon to design any building structure.

In the absence of such a course as above mentioned, I have submitted for a thesis the de-

sign, plans and specifications, of a reinforced concrete building.

PART I.

ASSUMPTIONS.

To put the problem upon a complete practical working basis, I have made the following assumptions.

1. The design is governed by the "Proposed Building Ordinance of Chicago, Illinois", published June 27, 1910.

2. The building lot to be located in such a part of the city as would require a neat architectural design.

3. The building to be located upon a corner lot 150 feet front and 55 feet deep, with a public alleyway upon one side.

4. The building to be four stories, basement and roof.

5. The building to be a fireproof structure.

6. The building to be used for manufacturing purposes.

7. The building to be of reinforced concrete throughout.

8. The floor loadings and heights of ceilings being selected as follows:

(a) Roof - Snow load of 30# per aquare foot.

(b) Fourth floor - ceiling 11'0" - L.L. 150# to be used for storage.

(c) Third floor - ceiling 11'0" - L.L., 100# to be used for furnishing room or type-setting etc.

(d) Second floor - ceiling 11'0", L.L. 150# per square foot for light machines as lathes, sewing machines, job presses or linotype machines, etc.

(e) First floor - ceiling 12'0", L.L., 300# per square foot to be used for large machines such as news paper presses, looms, etc.

(f) Basement - ceiling 14'6", to be used for heating plant, storage, etc..

9. Foundations built upon a soil assumed to

carry 3500# per square foot.

10. Timber piling not to carry more than 50,000 pounds per pile.

PART II.

DESIGN OF BUILDING.

Guide.

1. Proposed building ordinances of Chicago, published June 27, 1910.

2. Principles of Reinforced Concrete Construction - by Turneaure and Maurer. Published, 1909.

3. Designing Methods - Vol. I, No. 2. Published by the Corrugated Bar Company, June, 1908.

4. An interview with Mr. Benjamin E. Winslow M.W.S.S. with Holabird & Roche, Architects of Chicago.

THEORY AND ALLOWABLE STRESSES.

The straight line theory described in "Principles of Reinforced Concrete Construction", using safe loads for materials as follows:

Steel in tension 15000# per square inch.

Concrete in compression 600# per square inch.

Concrete carrying no tension.

Concrete good for a 30# per square inch in shear.

Concrete beams reinforced with stirrups good for 80# per square inch in shear.

$$\text{Ratio } n = \frac{\text{Modulus of Elasticity of Steel}}{\text{Modulus of Elasticity of Concrete}} = 15.$$

The weight of the outside wall was assumed as 10,000# on each girder. Each girder supporting the wall between it and the floor above.

The weight of the fire wall was assumed 1' x 4' x 18.75' x 150# = 11,250# per roof girder.

DIAGRAMS USED.

"Principles of Reinforced Concrete Construction"

Slab table #6 ----------------------page 297.

Rectangular beam diagrams-----------page 277.

T Beam diagrams---------------------pages 280-283.

NOTATION.

fs denotes unit fibre stress in steel, # per square inch.

fc denotes unit fibre stress in concrete # per square inch.

n denotes ratio Es/Ec.

L denotes length of beam in feet.

M denotes total bending moment, inch pounds.

W denotes total load on beam.

w denotes load per foot.

L.L. denotes live load.

D.L. denotes dead load.

Mc denotes bending mements of concentrated loads inch pounds.

Md denotes bending moment of distributed loads inch pounds.

b denotes breadth of rectangular beams and breadth of flange of T beams, inches.

b' denotes breadth of web of T beams, inches.

d denotes distance from the compressive face to the plane of the steel, inches.

t denotes depth of flange on floor slab.

Ac denotes area of concrete, square inches.

As denotes area of steel, square inches.

R denotes coeficient of resistance of concrete and steel.

p denotes percentage of steel reinforcement, equals

$$\frac{As}{bd}$$

P denotes allowable stress in stirrup.

V denotes total shear on section pounds.

v denotes shear taken by concrete.

V1 denotes shear taken by stirrups, equals V-v.

S denotes stirrup spacing, inches.

Beam Formulae.

1. Moments -

   Floor Slabs and Beams.

   M equals 1/12WL.

   Girders.

   M equals 8/10(Mc + Md) equals 8/10 (Px + 1/8WL) equals 1/10WL.

2. Moment area of beam -

   bd^2 equals M/R

   (R obtained from Curves, Page 277 or 283)

3. "b" shall not be greater than 3b'.

4. Shear -

   V equals W/2.

5. Shear Area of Beam equals V/80.

6. Stirrup spacing -

   S equals Pd/v.

Selection of Column Centers.

As light is a governing factor in a manufacturing building the columns should be spaced as far

apart as possible, not making the length of beams too great however for economy.

I decided to have eight column spaces on the front giving a space of 18.75 feet between columns, and three columns on the side giving a spacing there of 18.33 feet centers. Hence the beams were designed 18.33 feet, total length; and spaced 6.25 feet centers. The girders for a total length of 18.75 feet. For uniformity the exterior girders, both front and side, were designed alike. The front roof girder was afterward changed to fit the condition of the slanting roof.

DESIGN.

The design of one floor will be carried completely through to show the method used and the stresses, etc. of all other floors will be tabulated in form.

THIRD FLOOR DESIGN.

L.L., 100# per square foot over area.

Floor Slab - L equals 6.25 ft.

Obtained from Table #6, Page 297.

Space of 6-7 feet gives -

t equals 3"

As equals .202 sq. in. per ft. of slab.

Weight equals 37# per sq. ft.

Use Expanded Metal Mesh "No. 10 Heavy, having an area of .267 sq. inches per ft. width.

BEAM (See plate #1)

Loading - weight of slab	37#	per sq.ft.
L.L.	100#	" " "
Total	137#	" " "

Imposed load equals 137 x 6.25 x 18.33 equals 15,700#.

Assume a beam. d equals 15" -- b' equals 7".

Weight of beam equals 7(15-3)/144 x 150 x 18.33 equals 1600.

W equals 15,700 + 1600 equals 17,300

M equals 1/12WL equals 1/12 x 17300 x 18.33 x 12 equals 317000"#s

t/d equals 3/15 equals .2.

R equals 80 (from curves page 283)

b equals M/Rd^2 equals $317000/80x15^2$ equals 17.6".

Required shear Area, equals b'd equals V/80 equals 17300/2x80 equals 108 square inches.

Shear area on hand equals 15 x 7 equals 105 sq.in.

Reinforcement -

fs/fc equals 25

t/d equals .2

p equals .58% (from curves Page 280)

As equals bdp equals 17.6 x 15 x .0058 equals 1.53 sq. in.

Use5 - 5/8" round rods A equals 1.534 sq. in.

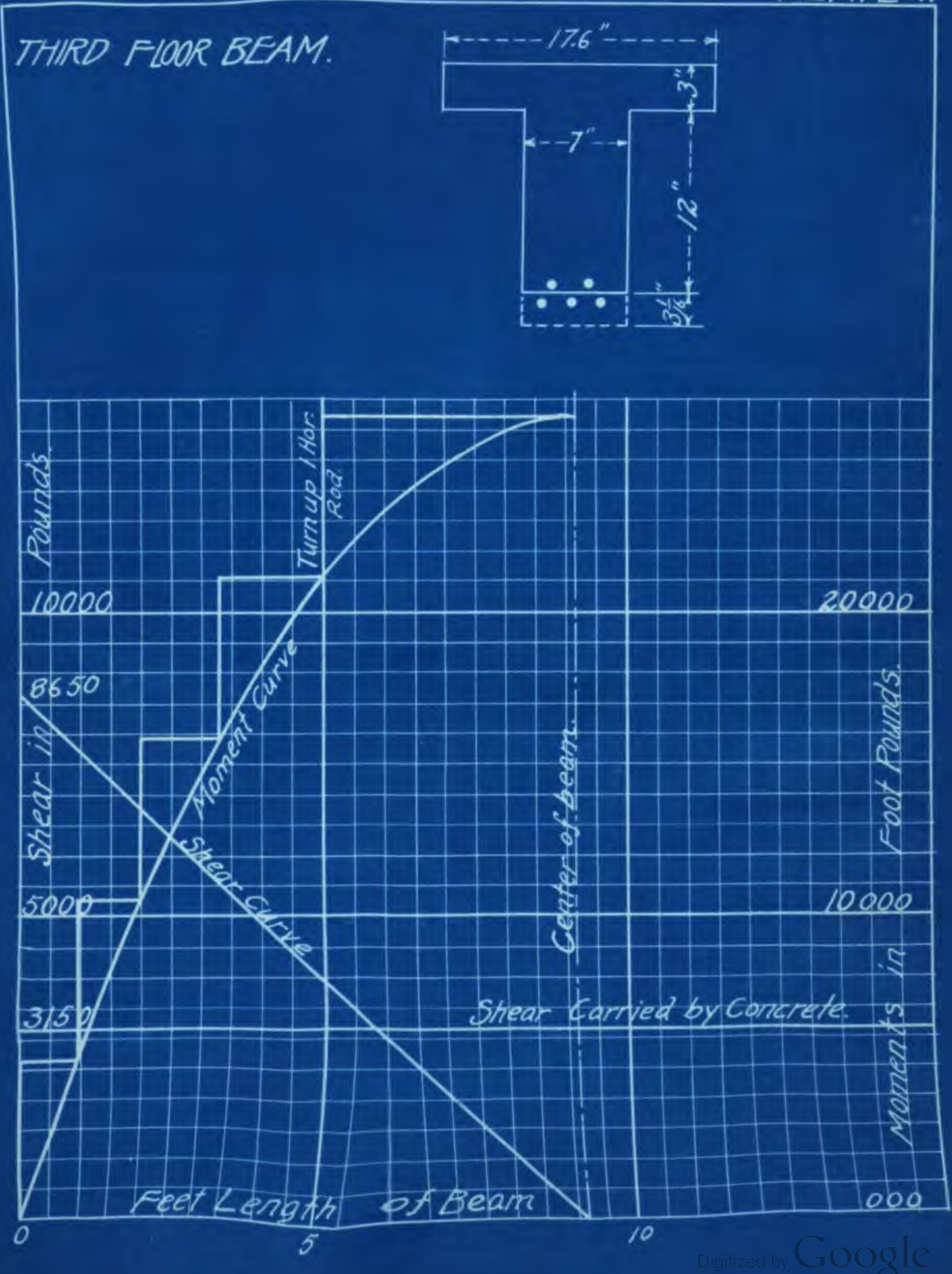
Vertical stirrups -

V1 equals V-v equals 8650 -30 x 15 x 7 equals 5500#.

3/8" ϕ stirrups will be used.

PLATE I.

THIRD FLOOR BEAM.



P equals 2 Area x 15000 equals .1658 x 2 x 15000 equals 3316.

S equals Pd/Vl equals 3316x15/5500 equals 9" for end spacing.

However the maximum spacing for stirrups is one half the depth of the beam, hence 7" will be used as the spacing up to 6 feet from both ends of the beam or where the V curve crosses the v curve.

The horizontal rods are turned up one at a time in plate #1, but for uniformity throughout the building the rods were turned up alike.

Two inches of concrete is added on below the steel for bond and protection from fire.

Inside Girder -

The concentrated load on the girder is composed of the shears of four beams, two of each applied at the 1/3 point. Hence the beam may be cut in half and one reaction taken.

Mc equals 17300 x 6.25 x 12 equals 1,300,000"#s

Assume a Girder:

b' equals 11"

d equals 22"

t equals 3"

Weight equals 11x19/144 x 150 x 18.75 equals 4090#.

Md equals 1/8 x 4090 x 18.75 x 12 equals 115000"#.

Mc + Md equals 4090 + 115000 equals 1,415,000"#.

M equals .8 x 1415000 equals 1,132,000"#s.

t/d equals 3/22 equals .136.

R equals 62.

p equals .45%.

b equals $113200/62 \times 22^2$ equals 37.7" which will be close enough.

Required shear area equals $\frac{17300 + 2045}{80}$ equals 242 sq. in.

Shear area on hand equals 22 x 11 equals 242 sq. in.

Vertical stirrups -

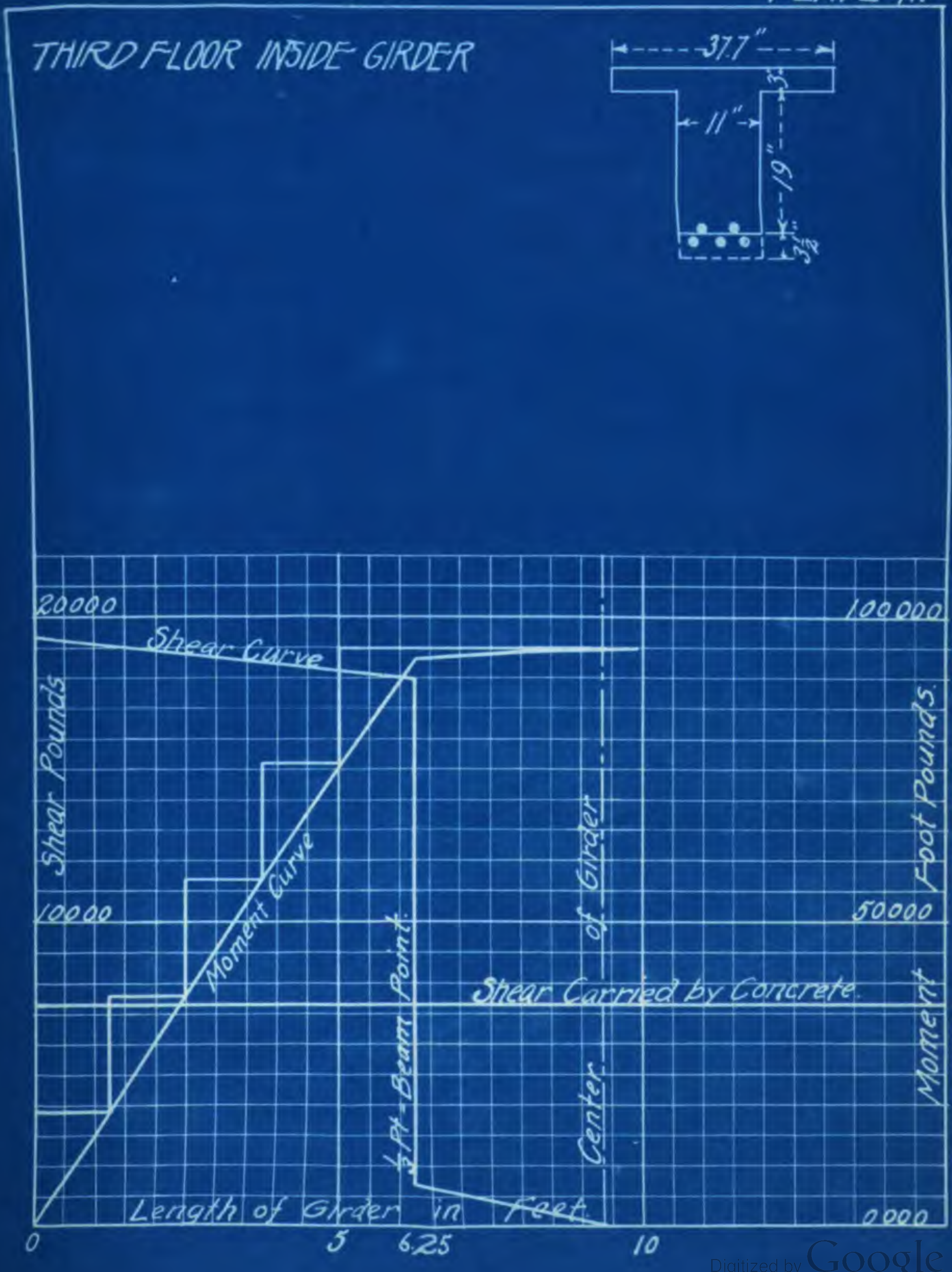
V1 equals V-v equals 19345 - 30 x 22 x 11 equals 12085.

Use 3/8"ϕ stirrups 3316x22/12085 equals 6.5" spacing up to beam point on 1/3 span.

Reinforcement: As equals bdp equals 37.7 x 22 x.0045 equals 3.73sq.in. Use 5 1"ϕ Rods. As=3.9270sq.in.

PLATE II.

THIRD FLOOR INSIDE GIRDER



See plate #2 for graphical date manner of turning up rods, etc.

Outside Girders:

D. L. From curtain wall assumed as 10,000#. Concentrated load will be the shear of two beams here instead of 4 as on inside girders, one applied at each 1/3 point.

Mc equals 8650 x 6.25 x 12 equals 648000"#. For rectangular beams R equals 97 and p equals .75% constant throughout.

Assume a beam. b equals 13", d equals 26".

Weight 26x13/144 x 150 x 18.75 equals 6590

Imposed D. L. " 10000

Total distributed load " 16590#

Md equals 1/8 x 16590 x 18.75 z 12 equals 465000

Mc + Md = 648000 + 465000 equals 1,117,000"#

M equals .8 x 1,117,000 equals 888,800"#s

d^2 equals 888800/97x13 equals 705. d equals 26" as assumed.

Required Shear Area V equals 8650+8295/80 equals 336 square inches.

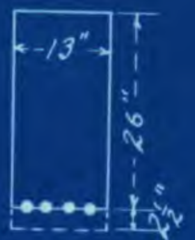
Shear area on hand equals 338 sq.in.

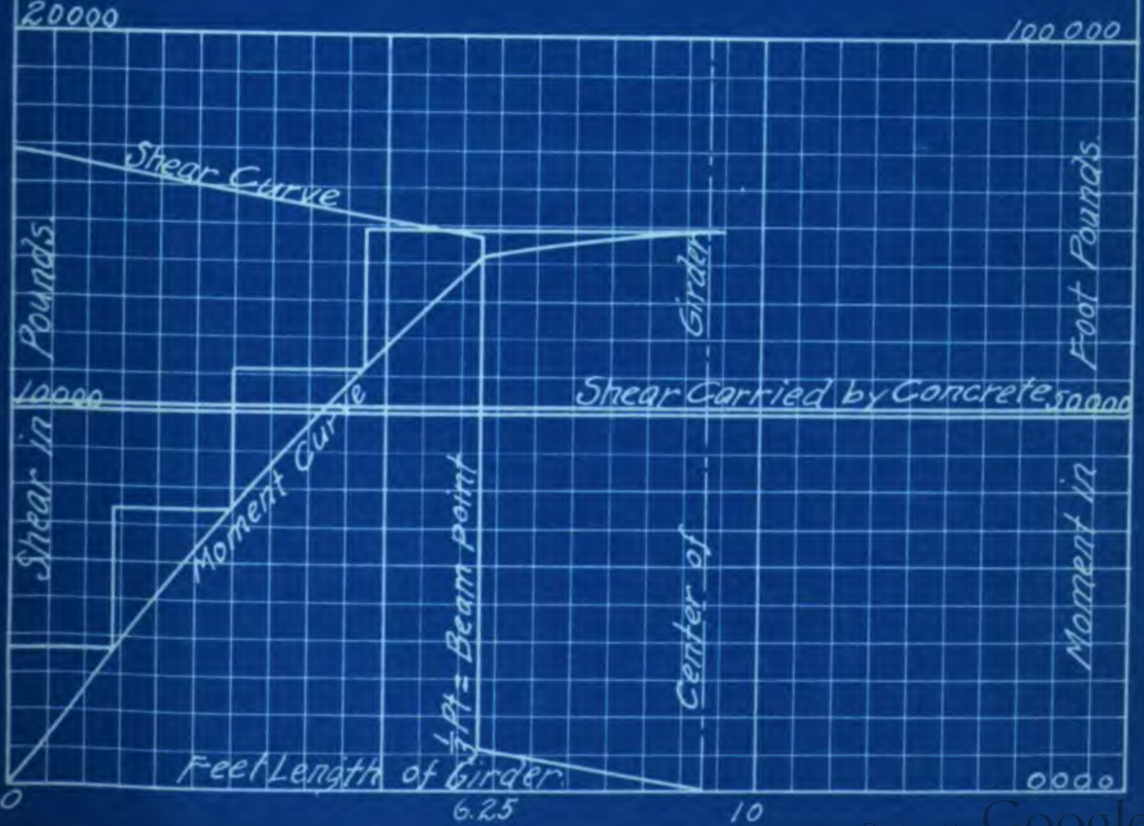
Reinforcement--

As equals 338 x .0075 equals 2.53 sq.in.

PLATE III.

THIRD FLOOR OUTSIDE GIRDER





Number of Girder
G1
G2, 3.
G4
G5, 6
G7
G8,9.
G10
G11, 13
G12

equals

g to

ents,

per

rete

Use 4-7/8"ϕ rods As equals 2.4052 sq.in.

Vertical stirrups.

v_1 equals V-v equals 16875 -26 x 13 x 30 equals 6735#.

Use 3/8"ϕ stirrups .

S equals 3316x26/6735 equals 12.8" spacing to beam point at 1/3 span.

See Plate #3 for graphical presentation of moments, shear, turning up of horizontal rods, etc.

Column Design . Third to second floor.

Maximum stress on concrete columns is 400# per sq. in.. Vertical steel area shall be 2% of concrete area.

Inside Columns:

Total load from above 3rd floor	109,485#
Wt. of column from 4th to 3rd floor	
421/144 x 150 x 13.5 equals	5,930
L.L., brought to Column by 3rd floor (18.75 x 18.33 x 100 x .80)	27,500
D.L. brought to Column by 3rd floor	
1. Wt. of slab = 18.75 x 1833 x 37=	12,730
2. Wt. of 3 beams 15x7/144 x 150 x 18.33 x 3 =	6,010
3. Wt. oflgirder 247.5/144 x 150 x 18.75 =	4,840
Total load	166,495#

Ac equals 166,495/400 equals 416 sq.in.

Use 20.5" x 20.5" equals 420 sq. in.

As equals 420 x .02 equals 8.40 sq. in.

Outside dimensions of Column allowing 2" outside of steel will be 24.5" x 24.5".

Outside Columns:

Total load from above 3rd floor	81,615#
Wt. of column 4th to 3rd floor, 335/144 x150x135	4,710
L.L. brought to column by 3rd floor, is 1/2 of inside column load,	13,750
D.L. brought to column by 3rd floor is 1/2 of inside column load,	9,860
Wt. of one outside girder equals 270.5/144 x 150 x 18.75, equals	7,220
Wt. of 1 1/2 beams equals 1/2 of beam load for inside column,	3,005
Total Load	120,160#

Ac equals 120600/400 equals 302 sq. in.

Use 17.5" x 17.5" equals 306 sq. in.

As equals 306 x .02 equals 6.12 sq. in.

Outside diameter equals 21.5".

Outside columns were given the same diameter throughout their length for architectural effect. However the steel area was kept as designed. Thus outside corner columns were made 33" x 33" and all other

PLATE IV.

COLUMN LOADINGS

OUTSIDE COLUMNS

FLOOR	LOADS #					REQD. AREAS	
	FROM ABOVE	WT. OF COL. ABOVE	L.L. FROM FLOOR	D.L. FROM FLOOR	TOTAL LOAD	CONCRETE Sq. in.	STEEL Sq. in.
ROOF TO 4TH.			5140	31485	36625	92	1.83
4TH. TO 3RD.	36625	2565	21900	20525	81615	204	4.08
3RD. TO 2ND.	81615	4710	13750	22085	120160	302	6.04
2ND. TO 1ST.	120160	4250	19350	20525	164285	411	8.40
1ST. TO FOOTINGS	164285	6570	38700	28735	238290	595	12.0
	238290	10600			248890	Load on	Footing.

INSIDE COLUMNS

FLOOR	LOADS #					REQD. AREAS.	
	FROM ABOVE	WT. OF COL. ABOVE	L.L. FROM FLOOR	D.L. FROM FLOOR	TOTAL LOAD	CONCRETE Sq. in.	STEEL Sq. in.
ROOF TO 4TH.			10280	12500	32780	82	1.64
4TH. TO 3RD.	32780	2565	43800	30340	109485	274	5.48
3RD. TO 2ND.	109485	5930	27500	23580	166495	416	8.32
2ND. TO 1ST.	166495	5850	38700	30340	241385	610	12.5
1ST. TO FOOTINGS	241385	9780	77400	41620	375285	940	18.8
		17000			392285	Load on	Footing.

outside columns were made 24 1/2" x 24 1/2".

FOOTINGS.

Inside column footings: See Plate 3-A

Weight on footing equals 392,285# or 400,000# including the weight of the footing.

Required area equals 392,285/3500 equals 112 sq.ft. which would be 33.5' x 33.5' more area than is on hand, hence piling will have to be used.

Use 5 piles each taking 50,000#.

400,000 - 5 x 50,000 equals 142,285# left for the soil to bear.

Area equals 142,285/3500 equals 43.5 sq. ft. 6.5 ft.

The footing will be designed as a cantilever beam the support being at the column. The pressure will be a uniform load of 400,000/43.5 equals 9200# per sq. ft. asting upwards.

A section one foot wide, parallel to the side, will be taken as the beam.

This will give a rectangular cantilever beam 1.96' long with a uniform load of 9200# per sq. ft.

Depth required by moment -

M equals 1/2 WL equals 1/2 x 9200 x $\overline{1.96}^2$ x 12 equals 212,500"#.

d^2 equals 212,500/97x12 equals 183

d equals 13.5".

Depth required by shear.

V equals 9200 x 1.96 equals 18,000#.

A equals 18000/80 equals 226.

d equals 226/12 equals 19" which will be used.

p equals .75%.

Steel area per foot width equals 19 x 12 x .0075 equals 1.71 sq. in.

Use 3 3/4"ø rods per ft. of width parallel to sides and 2 1/2"ø rods per foot of width parallel to diagonals.

Stirrups Spacing:

Use double 3/8"ø stirrups per ft. width.

P equals 2 x 3316 equals 6632.

S equals 6632 x 19/18000 equals 7" spacing.

Weight of footing 6.5 x 6.5 x 150 equals 12,670# which is close enough so that calculations will not need to be revised.

Outside Column Footings: See Plate 3-A

Assume a L.L. of 150# per sq. ft. on the sidewalk and a weight of 50# per sq. ft. Then the load upon each footing from the walk is 15x18.5 x 200/2 equals 27,700#.

Use 30,000#.

Load brought upon footing from the building	248,890#
" " " " " side walk	30,000
Total	278,890
Allowing 8000# for weight of footing	8,000
Total	286,890
Use	287,000#

Load upon soil	287,000#
Load carried by 4 piles	200,000
Load carried by soil	87,000#

Bearing area equals 87,000/3500 equals 25'. Use 5'x5' base.

Load per sq. ft. equals 11,500# acting upward on a cantilever beam, 1 ft. wide, supported at the column.

Depth required by moments:

M equals WL/2 equals 11,500x12 x$\overline{2.5}^2$/2 equals 430,000"#s.

d^2 equals 430,000/97x12 equals 370

d equals 19.3".

Depth required by shear:

d equals 11,500x2.5/30x12 equals 30" which is the effective depth.

The steel area. As equals 30 x 12 x .0075 equals 2.7 square inches.

Use 4 - 3/4"ϕ Rods parallel to the sides.

5 - 1/2"ϕ Rods " " " diagonals.

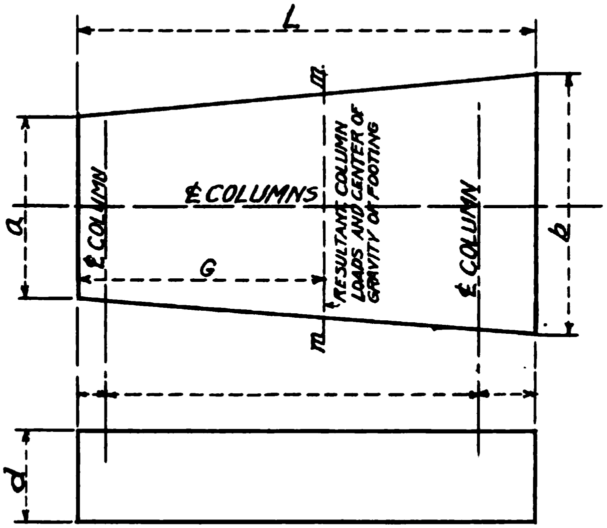
Stirrup spacing will be every foot, using the same type of stirrup as in the other footing.

Combined Footing: See Plate 3-A.

On the lot side of the building no part of the structure can extend over the building line. Therefore a footing would necessarily be designed which just came up to the line. I first tried to set the footing back under the building and make a cantilever girder projection under the wall; but such was impracticable because of the enormous depth of such a concrete girder. I finally decided upon a combined footing, combining the outside column with the inside column opposite, distributing the area proportionally. Such a design is explained in "Designing Methods" Vol. 1. No. 2. Edited by the Corrugated Bar Company.

Since the column loads are unequal, the footing will have a trapezoidal shape, and by fixing its length, since the area is available, the length of the two parallel sides can be calculated for the con-

dition of uniform load.



Let G equal distance from small end to center of gravity of footing and to the resultant of column loads.

If A equals area of trapezoid, we can determine the ends "a" and "b" from the following formula:

b equals $2A/L(3G/L - 1)$

The average width equals $a+b/2$ must equal A/L and a equals $2A/L - b$.

The uniform load acting upwards is obtained and a strip 12" wide over the entire length is figured as a beam supported at the columns with a uniform load of the soil pressure.

Design:

Load on the wall column	238,290#
Load on the interior column	375,285
Assume footing about 3.5' deep wt.	80,000
Total Load	693,575#

Area equals 693,575/3500 equals 198 sq. ft.

L equals 20.13 feet. G equals 11.873 from outside end.

b equals 2x198/20.13 (3x11.873/20.13 - 1)

equals 19.6 (1.77 - 1) equals 15.1'.

a + b/2 equals 198/20.13.

a equals 198x2/20.13 - 15.1

a equals 19.6 - 15.1 equals 4.5'

Beam Effect:

Reaction equals 3500/2 x 17.485 equals 30,600#.

M equals 3500/8 x $\overline{17.485}^{2}$ x 12 equals 1,600,000"#s

Moment Depth - d^2 equals 1,600,000/97x12 equals 1378 . d equals 37.1"

Shear Depth equals 30,600/80x12 equals 32". Use 38".

As per foot width equals 38 x 12 x .0075 equals 3.42 square inches.

The reinforcing rods are shown on the detail drawing.

BASEMENT RETAINING WALLS.

The earth pressure at the bottom of the wall was taken at 400# per sq. ft.

A horizontal strip of the wall 12" wide was taken having length of 18.33 feet or the distance between the columns.

From the slab table for L.L.400#, span 18.33', a slab of 12" thick was taken, having a steel area of .965 sq. ins. per foot width of slab. The reinforcing was selected as is shown on the detail sheet. 1/2"ϕ horizontal rods were selected being spaced at 6" centers at the bottom and the spacing increasing as the pressure decreased. In addition to this expanded metal was also used throughout; and vertical rods every 2 feet. A base of 2' x 2' was placed at the bottom of the wall so that the wall would not be supported entirely by the columns.

SIDE WALK.

The side walk was chosen as 15 feet wide from the building line to curb. Each building panel was divided into five sections using a beam at each column and four intermediate beams spaced evenly. The live load on the side walk was taken as 250# per sq. ft.

From the slab tables a slab 3" deep with a steel area of .202 sq. ins. of steel per foot width. Total weight of 36.5# per square foot.

Beam Design:

LL. equals 250 x 3.5 x 15 equals	13,100#
D. L. equals 36.5 x 3.5 x 15 equals	1,915
Imposed Load	15,015#

Assume a T beam. d equals 14" b' equals 7".

Weight equals 11x7/144 x 150 x 15 equals 1150

W equals 15015 + 1150 equals 16170#

t/d equals 3/14 equals .214. R equals 82.

p equals .6%.

b equals 16,170x15x12/12x82x14^2 equals 15".

Shear Area required equals 8085/80 equals 101 sq.in.

Shear Area on hand equals 98 square inches.

Steel Area - As equals 15 x 14 x .006 equals 1.26 sq. in.

Use 3 3/4"ϕ rods. As equals .4418 x 3 equals 1.3254sq.in.

Stirrup spacing:

Use 3/8" stirrups.

V_1 equals 8085 - 2940 equals 5145

S equals 3316 x 14/5145 equals 9" space stirrups 7" or 1/2 depth of beam up to 1/3 point.

Girder Design:

There will be a concentrated load of 8050# at each 1/5 point of the girder making 2 equally placed loads about each hald of the firder. Length of the girder will be 18.5'.

Reaction equals 2 x 8085 equals 16,170#.

M_c equals (16,170 x 7.4 - 8085 x 3.7) 12 equals 1,178,000"#s.

Assume a girder 12" wide which will be the width of the retaining wall and make the retaining wall act as the beam. Then the weight of the girder need not be brought in the calculations.

d^2 equals .8 x 1,178,000/97x12 equals 810.

d equals 28.4".

Steel Area: As equals 12 x 28 x .0075 equals 2.52 sq.in.

Place 4 7/8"ϕ Rods in the retaining walls 28" below the slabtop. The shear will be taken care of by the wall and the expanded metal which extends up through the girder.

Columns and Retaining Wall under side walk:

Load brought by 2 girders	32,340#
" " " 1 beam	8,085
Total	40,425#

Ac equals 40425/400 equals 101 square inches.

As equals 101 x .02 equals 2.02 square inches.

A buttress is to be placed under the beam point 12" thick and sloping from the wall face to a base of 2 feet; as is shown in the detail sheet.

The wall and the buttress together make up the column. 4 - 3/4"ϕ rods are used vertical in the wall column and 2 1/2"ϕ rods slanting in the buttresses. The detail drawing of the wall and column together is shown on detail drawing. 3-A.

STAIRWAYS.

The stairways are designed as a monolithic structure, with a landing placed between the two floors. The landing and stair slab are designed with a 50# per square foot Live load. The load on the steps would really be more than 50# per square foot when resolved into a component perpendicular to the stair slab.

For uniformity of design the beams and landing slabs were made uniform throughout. A sample design will be here shown, using the stairs between the first and second floors.

Stairway Design:

Total height, 13.75 feet. Landing height 6.875 feet.

The sum of rise and tread should be about 17".

Rise equals 6 11/32" Tread equals 11".

26 x 6 11/32 equals 12' - 9".

11" x 12 equals 11' - 0".

Slant Length equals $\sqrt{11^2 + 6.875^2}$ equals 12.97 feet.

From slab tables a 6" slab with .427 sq. in. of steel will be required. 2" of concrete below the steel. This will weigh 80# per sq. ft.

Landing slab 3" with .202 sq. inches of steel. 1 1/2" of concrete below steel. Weight 38# per sq. ft.

Landing Beam. B4.

The landing beam holding the stairs and landing will be approximately 18 feet long. Each leaf of the stairs will be 8 feet wide leaving 2 feet at the center clear. The stair load will be considered as an equivalent uniform load over the 18 feet.

L.L. + D. L. from steps equals 130/2 x 12.97 x 16 equals 13,220 #.

L.L. + D.L. from landing slab equals 18/2 x 88 x 6 equals 4750.

Total equals 17,970#.

Assume a rectangular beam. b equals 12". d equals 19"

Weight equals 12x19/144 x 150 x 18 equals 4280#.

W equals 17970 + 4280 equals 22,250#.

M equals 1/12 x 2250 x 18 x 12 equals 400,000"#s.

d^2 equals 400,000/97x12 equals 344. d equals 18.6". Use 19".

Area required by shear equals 11125/80 equals 139 sq. in.

Area on hand equals 228 sq. in.

Steel Area equals 12 x 19 x .0075 equals 1.70 sq.in. Use 4 3/4"ϕ Rods having an area of 1.7672 sq. in.

Stirrup spacing - Using 1/4"ϕ stirrups.

P equals .0491 x 2 x 15000 equals 1473.

S equals 1473 x 19/4285 equals 6.6" Use 7" spacing over the entire beam.

End Beam, B3.

This beam has applied at one point taken at 7 feet from the left a concentrated load, the end shear of B4 equal to 11125#.

Left Reaction equals R equals 11125x10.75/17.75 equals 6730#.

Assume a rectangular beam. b equals 12" and d equals 23". Weight equals 12x23/144 x 150 x 17.75 equals 4900#.

Total Left Reaction equals 6730 + 2450 equals 9180#.

Taking moments about the load for the section to the left of the load.

M equals (9180 x 7 - 1930 x 3.5)12 equals 690,000"#s.

d^2 equals 690000/97x12 equals 590. d equals 24.3"

Shear area required equals 9180/80 equals 115 sq. in.

Shear Area on hand equals 228 sq. in.

Use a beam b equals 12", d equals 24". This will not have to be redesigned, for the increase of 1" depth over the assumed weight, and will be accepted as close enough.

Steel Area equals 288 x .0075 equals 2.16 sq.in.

Use 4 - 1"ø rods. As equals 3.1416 sq. in.

Using 1/4" stirrups P equals 1473.

S equals 1473x24/540 equals 65.6" spacing.

Stirrups are not necessary but will be used, spaced 1/2 of the depth or 12" over the entire beam.

Landing beam in the wall. B5.

There will be a beam effect in the wall to support 1/2 the landing load. The wall will be 8" thick so this will be the breadth of the beam.

D.L. + L.L. from the landing equals 4750# equals W.

M equals 4750/12 x 18 x 12 equals 85500"#s.

d^2 equals 85500/97x8 equals 110 sq. in.

d equals 10.5".

The shear need not be considered as there is plenty of depth available.

Steel Area required equals 88 x .0075 equals .66 sq. in.

However 3 - 3/4"ø rods were used to increase the

stiffness.

The stairway and parts pertaining are shown in the detail sheet 3-A with the method of reinforcing complete. The reinforcing was increased some to avoid the cracks in the stairs, and for cases of emergency, such as heavy loading of the stairs in case of fire or panic, etc.

APPENDIX

BUILDING PROPOSALS AND SPECIFICATIONS

SPECIFICATIONS
FOR THE
MANUFACTURING BUILDING
OF THE
SMITH MANUFACTURING COMPANY.

____

____
Sup. Archt.

- - - - - - - - - - - - - - - - - -

GENERAL CONDITIONS

I. BIDS. Sealed proposals will be received for the construction of the ______________________________ up to ______________________________.

II. FORM OF BIDS. Bids must be on the printed forms furnished by the architect, and in conformity with the directions found therein. All bids must be sealed and addressed to J. W. Lowell, Architect, Chicago, accompanied by a certified check to the amount of two per cent of the bid, drawn to the order of the said architect, which the bidder must agree to forfeit if he fails to enter into contract for the work bid upon within five days after written notice of

acceptance of his bid. The checks of all bidders will be returned as soon as the contracts are let, except that the check of the successful bidder will be returned upon approval of the contract by the President of the Smith Manufacturing Company.

III. BOND. The Contractor must furnish a good and sufficient bond to the amount of $10,000, with sureties satisfactory to the President of the Smith Manufacturing Company, conditioned upon the faithful performance of his contract, and the payment of all claims for labor performed or materials furnished in and about the completion of his contract.

IV. DEPOSIT FOR PLANS. Contractors taking plans and specifications from the office of the Architect will be required to deposit as surety for their return at a set date $10.00. In the event of the Contractor not returning the plans or specifications on the day set for such return, the Secretary will deduct the sum of $2.00 from the deposit for each and every day the plans and specifications are so withheld.

All plans and specifications must be returned to the Supervising Architect before certified checks will be returned to bidders.

V. DAMAGES AND INJURIES. The Contractor will be held responsible for all damages to persons or property occurring in any manner by reason of his prosecution of the work, and the President of the Smith Manufacturing Company is empowered to withhold all moneys due or to become due to the Contractor and to proceed at law against the Contractor and his sureties on his bond, to fully protect himself against any claim or claims whatsoever arising from such causes as above stated.

VI. THE OWNER. THE SMITH MANUFACTURING COMPANY, A CORPORATE BODY under the laws of Illinois, for which the work is being performed, is for convenience in these specifications spoken of as THE OWNER.

VII. OFFICE OF THE DRAWINGS. The drawings and such writings, interlineations, figures and details as may be made upon them are to be considered a part of and as illustrating the specifications. All work or material shown on the plans and ommitted from the specifications or vice versa shall be done under the contract price, the same as if shown or mentioned in both.

The Contractor shall check the drawings and specifications before laying out the buildings or work, and report to the Supervising Architect any discrepancies

discovered. Any unforseen difficulties or discrepancies arising during the progress of the work must be promptly reported to the Supervising Architect, and his approval of any necessary changes obtained before the work on them proceeds.

VIII. DUTIES OF CONTRACTOR. The Contractor shall be held strictly to execute such work and to use such materials as hereinafter described. He will further be held to submit as to character of the materials used, and the work done, to the judgment of the Supervising Architect, and to secure from him all necessary certificates regarding payments on the contract; also written orders for all additions or deductions which may result from changes of design or plans.

IX. FOREMAN. The Contractor must have some competent person on the work to receive instructions and see when each particular part of the work is required. Subcontractors will not be recognized.

X. WORK AND MATERIALS. Upon being directed to do so by the Supervising Architect, the Contractor is bound in all cases to remove improper work or materials and to do so within forty-eight hours after receiving written notice from the Supervising Architect, but if the Con-

tractor, after having been directed as above to remove the same, shall refuse or neglect to do so, he shall not only suffer a deduction from the contract price of the difference in value of proper and improper work and materials, but shall also be liable for all damages of whatever nature or kind that may result from such causes.

The above provisions so apply in the same way to all materials or work used, made or fixed without the knowledge of the Supervising Architect and not approved by him. The Owner, under the direction of the Supervising Architect shall be at liberty, if in his judgment the case requires it, to replace the same and make good every part at the cost and charge of the Contractor.

XI. TESTING. All materials brought upon the job will be subject to sampling, inspection, analysis and testing at any time and all times by the Supervising Architect, and the Contractor must not use any materials tests of which are being made, until the approval of the Supervising Architect is obtained. Any material condemned by the Architect must be removed from the premises.

XII. DAMAGES AND DELAYS. This contract is to be completed, and must be finished throughout, as hereinafter described, on or before nine (9) months after

date of contract. Any delay in the entire completion of the work contracted for shall make the Contractor liable to the Smith Manufacturing Company in the sum of Fifty ($50.00) dollars per day as liquidated damages for each and every day of such delay of completion after nine (9) months after date of contract.

Bidders are advised that these damages are not fixed as a mere penalty, but are so fixed because the contract must be completed by the time set or such injury will be caused to the Smith Manufacturing Company as will doubtless exceed the sum named.

XIII. BEGINNING WORK. While the time of completion is specified to be nine (9) months after date of contract, no delay in beginning construction shall be made by the Contractor. The work of excavation shall be begun by ten (10) days after date of contract or as soon thereafter as the season permits, and construction shall go on rapidly and continuously to completion.

XIV. DELAY OF THE WORK. In case of delay by the Contractor in providing and delivering the requisite materials, or in advancement of the buildings or work, or on account of a deficiency of workmen, or for his misconduct, inattention or inability, the Owner shall be at

at liberty (after the Supervising Architect has given or left for the Contractor with his foreman or clerk, two days' notice in writing) to provide at the expense of the Contractor all such materials, and employ such number of workmen at such wages as the Supervising Architect shall think proper, and the cost and charges incurred shall be retained out of the contract amount and paid by a reservation from the estimates from time to time, or amounts thereof which may be due or recoverable as liquidated damages.

XV. CONTRACTOR'S RESPONSIBILITIES. The Contractor shall be required in all cases to use proper care and diligence in bracing and securing all parts of the work against wind, storm and frost, and against any possible danger of failure, collapse or damage during the progress of the work, and he will be held strictly liable for all damages which may accrue to any persons or property whatsoever by failure to do so. He must use proper judgment in all cases as to the amount of diligence and care required for the same and for the proper execution of the various constructions, and no excuse of ordinary care or quality of work will be allowed when the nature of the work required extra care.

It is understood by the Contractor that the building or work is entirely at his risk until the same is accepted, and he will be held liable for its safety to the amount of money paid him by the Smith Manufacturing Company on account of same, risk of fire excepted, as provided in the contract.

XVI. **CHANGES IN WORK.** **THE PRESIDENT OF THE SMITH MANUFACTURING COMPANY** reserves the right, by conferring with the Supervising Architect, to alter or modify the plans and these specifications in any particular, and the Supervising Architect shall be at liberty to make any deviation in the construction, detail, or execution, without in either case invalidating or rendering void the contract. And in case any such alteration shall increase or diminish the cost of doing the work, the amount to be allowed to the Contractor or Owner shall be such as may be equitable and just, as provided in Article III of the contract.

XVII. **EXTRA WORK.** Should any extra work be required or changes in the plans be made whereby the cost may be increased or diminished, all such changes must be determined and agreed upon before the change is made, and the amount, whether the increase or dimin-

ish in cost, must be endorsed upon the back of the contract.

XVIII. SUPERINTENDENCE. The Supervising Architect, J. W. Lowell, will be superintendent for the Owner, his duties being faithfully to enforce all the conditions of the contract and to furnish all necessary drawings and information that are required to properly illustrate the designs given; also to make estimates for the Contractor of the amount due him on the contract, in no case estimating any material or labor which is objectionable or has not become a permanent part of the work, and when the building is completed, to issue a final certificate to the Contractor, which certificate, if unconditional, shall be acceptance of the work.

It is not incumbent upon the Supervising Architect to notify the Contractor to attend to and have in readiness his own work and the requisite material at such time as the progress of the building or work may require.

If the Contractor does not attend to this part of his work and have his own portion of the labor and materials in readiness as they may be wanted to incorporate into the building, he will be held account-

able for all delays and damages in consequence of any such neglect to all and any persons whatsoever damaged by his neglect, and the Supervising Architect is empowered to withhold such funds from the contracting price as may meet the cost of such damages.

XIX. CERTIFICATES. Any payment made on work during its progress, on account of the contract or for extra work, shall be in no case construed as an acceptance of the work executed, but the Contractor shall be held liable to all the conditions of the contract until the work is finished and completed and accepted.

XX. COMPLETION AND ACCEPTANCE. All the specifications, designs, plans, details, elevations, and sections of each and every kind that the Contractor may have received, must be preserved and returned to the Supervising Architect before the final certificate is given; and the Smith Manufacturing Company must be notified by the Contractor that he is ready to have a settlement, so that if the SMITH MANUFACTURING COMPANY, or parties in interest, have any bills to file in, they can do so before the Supervising Architect makes his final certificate or adjustment between the parties.

The Supervising Architect's opinion, certificates, report and decision on all matters concerning this contract, shall be binding and conclusive, except as arbitration is provived for in the contract.

XXI. INTERPRETATION OF DRAWINGS. Should the Contractor or his representative obtain any explanation or interpretation from any of the employes in the Supervising Architect's office, which does not strictly conform to the plans, drawings, and these specifications, either for guiding in estimating or for furnishing materials and executing the work after the contract is closed, such interpretation will be of no avail with the Supervising Architect, no matter how definitely the explanation may have been given, unless the Supervising Architect's written order is given for the same. It is intended that the plans, drawings, and these specifications shall be the guide in executing the work and settling the contract, except as modified by such written orders as may be given and agreed upon between the President of the Smith Manufacturing Company, by the Supervising Architect, and the Contractor.

XXII. SUBSTITUTION OF MATERIALS. Wherever in the plans and specifications a specific manufacturer is

indicated, it is to understood that articles of equally good material and manufacture, if approved in advance in writing by the Architect, may be substituted, approval to be filed with the contract in the Office of the President of the Smith Manufacturing Company.

XXIII. CO-OPERATION WITH OTHERS. Each Contractor is to co-operate with other contractors on the building or work, so that as a whole the job shall be a complete and finished one of its kind; and he shall carry on and arrange his work in such a manner that none of the co-operating contractors shall be unnecessarily hindered or delayed in the progress of the work; and when this Contractor has finished his work he shall remove from the premises all tools, machinery, debris, etc., and (so far as he is concerned) leave the building or work and adjacent premises free and clear from all obstructions and hindrances.

All rubbish must be regularly removed and not allowed to accumulate on the premises.

XXIV. The Owner reserves the right to accept or reject any and all proposals.

GENERAL STATEMENT

Proposals shall be for the furnishing of all materials and for the entire construction of the Manufacturing Building of the Smith Manufacturing Company according to the plans and specifications. The following proposals are requested and no others.

PROPOSAL #1, for the furnishing of all materials and the entire construction of the building according to plans and specifications.

PROPOSAL #2, for the furnishing of all materials and the entire construction of the building according to the plans and specifications. Reinforcement shall be made by medium steel of pattern approved by the Architect and of the quality specified, no steel to be strained over 15,000 pounds per square inch of section. Compression in concrete not to exceed 600 pounds per square inch. No tension in concrete allowed. All steel to be properly secured before pouring concrete.

MASON WORK.

NOTE. Read the general conditions at the beginning of the specifications. Every requirement there contained applies to this contract the same as if here repeated. Note the general statement about proposals, and estimate in accordance therewith.

I. EXCAVATION. Excavate for the basement, piers, pits, foundations, areas and other constructions as shown on the drawings. Level all trenches and pier foundations at the right height. Excavate for dwarf walls and other constructions and leave all excavated portions level and smooth, ready for the cement floor. Excavated earth shall be satisfactorily disposed of by the contractor.

2. GRADE. The building grade and the location of the building will be furnished to the contractor.

3. BAILING AND PROTECTION. The mason shall keep the excavation free from water at all times, and shall protect the adjoining property from damage.

4. WATER AND MATERIALS FOR BUILDING. The Contractor shall furnish water and all materials for building purposes.

5. FOUNDATIONS. The bottom course of all foundations shall be of Portland cement concrete (for detailed specifications of concrete, see below) together with foundations for all piers and other parts of the superstructure.

6. CUT STONE WORK. All sills and other cut stone work except the steps and ramps shall be of Bedford, Indiana, limestone of first quality. Steps and ramps will be of concrete. Cut stone shall be chisel drove, sand rubbed, etc. as required. All stone work to be cut in the best manner by skilled workmen.

7. SETTING. The mason shall provide all derricks hoists and other apparatus, and set the stone in the best manner, leaving the work plumb, straight and true. Do all necessary trimming and adjusting of cut stone to make a perfect and acceptable piece of work. Provide mortar composed of fresh lime and clean washed bank sand for the work, and when the building is finished point up the joints with cement in a neat and workmanlike manner.

8. TERRA COTTA AND SETTING. The cornices of the second floor together with the cornices and coping of the upper portion of the building and incidental terra

cotta work shall be first class hard burned terra cotta of the same color and texture as the concrete work.

Set all terra cotta with cement mortar furnished by the mason. Furnish and place all necessary structural steel anchors and supports and point up all terra cotta as necessary, to make water tight work.

9. PROTECTION OF STONE. Protect all stone and terra cotta during the whole course of building operations by means of board coverings and otherwise as necessary.

10. SCAFFOLDS, ETC. Furnish all scaffolding, ladders, hoists and other apparatus, and grant the use of it to other workmen during the progress of the work or putting up work in connection with masonry.

11. COMMON BRICK. All brick walls will be laid of hard brick equal to Chicago hard burned mercantile brick. All curtain walls will be well bonded into the structure.

12. JOINTS. All brick facing outside and inside shall be neatly trowel struck.

MORTAR. Exterior face brick shall be laid

Mankato brick layers cement mortar or equal.

13. BRICK WORK. Bricks shall be wet in dry weather and laid in lime mortar with solid joints. Heading courses in common brick work shall be laid every sixth course. Courses shall be kept plumb and level from end to end of the building. The walls shall be leveled exactly for joists and girders with a heading course for bearings.

Leave all necessary openings, build slots, flues for vent and air. Flush up close to all window and door jambs, sills, etc. Build discharge arches over all openings.

Build in anchors, wood blocks, lintels and other things of like nature for the proper completion of the work.

14. IRON AND STEEL WORK. All square headed openings in outside walls and over all exterior doors in the building shall be supported by two steel angles to each opening, small openings to have 4" x 4" angles. Openings wider than 4' and less than 7' shall have two 6" x 4" angles. Larger openings in masonry, except where concrete girders are shown, shall have steel beams. Furnish and set all steel and iron work noted in the drawings in connection with exterior and inter-

ior. See diagrams for steam heating, etc. for further information. Furnish shop drawings for all work.

15. ORNAMENTAL IRON WORK. Furnish and place the iron thresholds for entrance and vestibule doors, the iron railings and cast newels for stairs and other iron work as shown and detailed.

16. OPENINGS. Leave openings for pipes and other apparatus of the building construction, and when the pipes are in place wall closely up to them.

17. SLOTS. Form slots in the brick work for soil pipes and vents, etc. as shown, extending from basement to roof.

18. FRAMES. Build up the masonry about door and window frames when they are plumb and straight. The carpenter will set the frames, but the mason will see that they are right before buildingup the masonry. He will be responsible for their being plumb when the masonry isfinished.

19. CUTTING AND PATCHING. The mason shall do all cutting, patching and mending necessary for any purpose in connection with the construction of the building.

20. TILE PARTITIONS AND FURRING. All interior partitions shall be formed of 3" hollow, fire proof tile.

All outside walls in all parts shall be furred with 2" hollow fire proof tile. Do all other tile furring necessary to form a perfect and sightly piece of work.

21. FLUE LININGS. All smoke flues shall be lined with tile flue linings.

22. POINTING AND CLEANING. When the entire work is complete the mason shall point up and clean down the entire building and underpin all stone work when the building is finished.

23. SHORING. The mason shall do all shoring, supporting and bracing of the adjacent property should such be necessary.

FINALLY. This contract contemplates and comprises a perfect and complete job of masonry, terra cotta, cut stone and iron work, and anything necessary to that result is hereby included the same as if particularly mentioned, described and detailed upon the plans and and details. When completed the contractor shall

remove all debris, tools, machines and appartus of every sort belonging to this work, leaving the premises free from anything of the kind.

CONCRETE WORK.

NOTE. Read the general conditions at the beginning of the specifications. Every requirement there contained applies to this contract the same as if here repeated. Note the general statement about proposals, and estimate in accordance therewith.

I. CONCRETE FOUNDATIONS. The foundations and all walls, piers, areas and other parts so shown or marked shall be of reinforced concrete.

2. CONCRETE FLOORS, GIRDERS, POSTS AND STAIRS. The floors shall be constructed of concrete beams with cross beams as indicated. The floor sheet shall be reinforced with expanded metal over the entire area. The contractor's attention is called to the detail of this work which shall be followed rigidly. The stairs shall be constructed of concrete except rails, balusters and newels. The entire work shall be supported by a system of reinforced concrete girders and posts as shown upon framing plans and details. Plain round rods will be used, bent as shown, with other reinforcement of stirrups, column ties, etc. as necessary for the work.

3. CONCRETE FORMS. A complete false construction formed of 2" plank dressed on one side next to the concrete shall be erected for this work. Forms for outside concrete surfaces must in addition to the foregoing be made so that an extra smooth surface will be given to the concrete. A surface without fins, seams or disfigurations of any kind. The false work must be accurately placed and rigidly supported and scaffolded to form. The forms shall remain in place until the concrete has attained its permanent set, and until it is able to bear the stresses brought upon it.

The false work for girders and posts shall be of 2" dressed planks especially framed and put together as necessary. Post forms shall be left open at the bottom for cleaning out.

False work for concrete joists and floor slab shall be formed into cells or boxes, firmly constructed and smoothly made so that they may be removed without taking apart. The cells shall be laid accurately upon the plank supports, and between all cells shall be laid wood furring strips of the size shown, extending in both directions.

These strips shall contain large nails at 2' - 0" centers or as detailed for bonding into the concrete, and shall not be removed from the joists when the wood supports and cells are taken down. The joists shall be shored up at the time the false work is removed until the concrete is thoroughly set. In the case of vertical walls the forms may be removed sooner so as to permit the surface to be finished as hereinafter specified.

MATERIALS

4. CEMENT. Cement will be of a first-class brand approved by the Architect. The contractor will be held responsible for the cement. He shall protect the cement and bags from injury. All hauling of material to the work shall be done by the contractor.

SAND will be coarse, sharp bank sand, free from quicksand, loam and organic matter. It shall not contain stones larger than 1" diameter for reinforced concrete, nor more than 25 per cent. of stone 1/4" in diameter and larger.

For plain concrete stones in the sand may not be larger than 1-1/2" in diameter, and in mixing the concrete if the proportion of stones in the sand exceeds 25 per cent. as above, the excess shall be counted as stone, not as sand.

CINDERS. Cinders must be clean and of a good grade.

CRUSHED STONE will be limestone 1" diameter, free from clay, dirt, and organic matter, and thoroughly screened over a 1/4" mesh, or washed gravel or other

similar stone satisfactory to the Architect. For plain concrete a larger size of stone may be furnished at the discretion of the Architect.

5. STEEL FOR CONCRETE REINFORCEMENT. The contractor shall furnish all steel for reinforcement of concrete work examine the plans and details for amounts and furnish test pieces for all work as required.

The steel used in reinforcement shall be of medium steel of an ultimate strength not exceeding 70,000 pounds per square inch. Its elongation shall not be less than 25 per cent. in eight diameters. The phosphorous content shall not exceed 1/10 of 1 per cent. All concrete columns shall have 1/4" horizontal steel rings at 6" centers throughout their height. All concrete beams and girders shall have unit stirrups as noted on drawings.

OTHER STEEL AND IRON. Build into the concrete all other steel and iron furnished by other contractors for this purpose.

MIXING CONCRETE MATERIALS.

6. MIXTURE FOR PLAIN CONCRETE. For concrete not reinforced the stone shall be of a size to pass a 1 1/2"

ring, and the mixture shall be one part cement, three parts sand and five parts stone.

7. MIXTURE FOR REINFORCED CONCRETE. Concrete containing steel reinforcement shall contain one part cement to two parts sand and four parts crushed stone passed through a 1" mesh, and absolutely free from clay and organic matter.

8. CINDER CONCRETE. Cinder concrete shall consist of one part cement, four parts sand and six parts clean cinders.

9. MIXING. All concrete for this work shall be mixed by a mechanical concrete mixer of a type satisfactory to the Architect. The concrete shall be mixed of a consistency to be readily brought to place in the moulds by a small amount of stirring and cutting with the spade. Excess of water must be avoided. Care must be taken to deposit the concrete promptly after being dumped from the mixer. The concrete shall be spaded well next to the forms to secure a good surface.

10. CONDUCT OF WORK. Before any concrete is placed in any part of the structure all reinforcement for such

portion must be completely in place and substantially held by wires or other device. The contractor shall follow the directions of the Architect as regards pouring, stopping at night and other like matters.

SURFACE FINISH OF CONCRETE.

11. CEMENT AND SAND FINISH. The Concrete floors shall have 1/2" finished surface consisting of one part cement to two parts sand, granite or other finishing material. This surface shall be put on from 24 to 48 hours after the concrete is laid.

12. CONCRETE PITS AND FOUNDATIONS. Excavate for and build all concrete pits and foundations as shown and detailed. Build in all anchor bolts according to diagrams. Make up templates as necessary. Exterior surfaces will be finished by scowring with a mixture of water and cement and a sand brick. Where no stresses will be brought upon exterior walls, girders or columns by removal of forms, such forms may be removed ffom 24 to 48 hours so that the surface may be accomplished with more ease and better results.

CONCRETE RETAINING WALL. Build the concrete retaining walls as detailed.

13. BASEMENT CONCRETE. The basement floor shall be laid upon a 3" layer of clean cinders. It shall consist of a 6" floor of Portland cement concrete, composed of one part cement to three parts of sand and five parts

of broken stone, 1-1/2" size. All basement floors shall have a 1" thick surface composed of one part cement and two parts sand, put on from 18 to 24 hours after the concrete is laid.

14. STEAM TRENCHES. Form concrete trenches for the steam pipes crossing the basement floors.

FINALLY. This contract contemplates a perfect and complete job of plain and reinforced concrete work, and anything necessary to that result is hereby included the same as if particularly mentioned, described and detailed upon the plans and details. When completed the contractor shall remove all debris, tools, machine and apparatus of every sort belong to this work, leaving the premises free and clear from anything of the kind.

CARPENTER WORK.

NOTE. Read the general conditions at the beginning of the specifications. Every requirement there contained applies to this contract the same as if here repeated. Note the general statement about proposals, and estimate in accordance therewith.

1. MATERIALS. All materials used in the construction of the building shall be of the grade specified. All dimension stuff shall be long leaved yellow pine or Oregon fir, free from large or loose knots, sap, shakes and otherimperfections. Framings shall be constructed in a substantial manner. All dimension stuff shall be of the sizes specified.

2. CLEANING AND SANITATION. The carpenter shall remove from time to time all debris from the building and finally leave the building broom clean for the painter. He shall provide a privy for the workmen and maintain in sanitary condition during the whole building period.

3. LINTELS. All masonry openings shall have wood lintels the full width of the wall, except such por-

tions as are supported by stone lintels, brick arches in circular heads or steel lintels.

4. CLOSINGS. When the condition of the building requires it, close in the window and door openings with canvas or other temporary closings to keep out the weather.

5. FURRING CEILINGS. All ordinary ceilings shall be cross furred upon the under side of the concrete or wood joists by 2" x 2" strips at 16" centers, nailed into the wood strips placed in the concrete by others to receive the lathing.

6. STRIPS. Furnish and set for the plumber all wood strips for the support of pipes and fixtures. Form pipe channels where necessary with pine covers screwed to place.

7. INCIDENTALS. Furnish to the mason all wood blocks, bond timbers, wood centers, templates and other items necessary for carrying out this work.

8. EXTERIOR WINDOWS. All windows except where shown otherwise shall have box frames with 1-1/8"

thick pulley stiles, 7/8" back and inside linings, 2" sills. Frames to have sliding sash 1-3/4" thick, hung on giant red spot sash cord running over 2-1/4" anti-friction pressed steel "American" $412-1/2 pulleys and nicely balanced on iron weights. All woodwork of window frames to be of second clear soft pine, except pulley stiles long leaved yellow pine; sash to be clear soft pine or clear cypress. Frames to have outside stiles of a form to permit hanging storm sash.

9. INSIDE WINDOWS. Windows shown on the interior shall be fireproof and metal set.

10. OUTSIDE DOOR FRAMES. The doors will be set in substantial oak frames not less than 2" thick. The upright supports between double doors to be at least 6" thick.

11. OUTSIDE DOORS. The outside doors shall be oak 2-1/2" thick. The vestibule doors shall be quarter-sawed, clear kilndried oak 2 1/4" thick, double thick, wedged, glued and screwed together, paneled and moulded as detailed. All transoms shall be 2 1/4" thick, the transoms the same material as the door.

12. INSIDE DOORS. All inside doors shall have 1-1/8" jambs and heads. Doors shall be 1-3/4" thick, moulded and paneled. The panels shall be of oak, three ply, all to be as detailed. Sash doors in corridors to have glass stops. All doors to be clear oak.

13. HANGING AND TRIMMING. Each door will be equipped with three butts, the lock, transom lifter, stops, and on double doors, the bolts, etc. Windows will have lock and lifts or other devices for operating. All to be put on by the contractor in proper form.

14. INSIDE FINISH. All woodwork shall be clear, kilndried stuff and shall not be delivered at the building until the plaster is dry. All shall be hand smoothed and sanded straight, and shall be free from knots, sap, stain or blemish. All baseboards to have 2" base shoe. See details.

FINALLY. The carpenter shall protect the interior of the building from the weather and other damage during the entier building period. The carpenter shall return twice to the building when ordered, for the purpose of going over the doors, windows, etc. generally and making them operate perfectly.

ROOFING AND METAL WORK.

NOTE. Read the general conditions at the beginning of the specifications. Every requirement there contained applies to this contract the same as if here repeated. Note the general statement about proposals and estimate in accordance therewith.

DESCRIPTION OF ROOF. The roof shall be a floor slab finished as other floors except that it is given a pitch as shown in detail.

ROOF COVERING.

1. COVERING FOR ROOF. The roof will be covered with a good coat of hot tar and clean pebbles not to exceed 1/2" in diameter and well graded. This coat shall extend one foot up the surrounding wall.

METAL WORK.

2. MATERIALS. Sheet metal shall be the best of the kind specified. Tin work shall be done with old method redipped tin approved by the Architect, galvanized iron with Juanita or Appolo brand, #24 and #26.

All metal work of every sort shall be painted with iron mineral paint of brand approved by Architect.

3. DOWN SPOUTS. Place 5" corrugated galvanized iron down spouts where indicated on the roof plan, and secure in each five feet by wrought iron ring fasteners. Use only curved elbows and hold the conductor far enough from the building to pass water tables and other projections. Water heads shall have #12 gauge copper wire strainers.

FINALLY. This contract contemplates and comprises a perfect and complete job of roofing and sheet metal work and anything necessary to that result is hereby included the same as if particularly mentioned, described and detailed upon the plans and details. When completed the contractor shall remove all debris, tools machines and apparatus of every sort belonging to this work, leaving the premises free and clear from anything of the kind. The contractor shall keep the roof in a water tight condition for one year after the completion and acceptance of the building.

PAINTING AND GLASS.

NOTE. Read the general conditions at the beginning of the specifications. Every requirement there contained applies to this contract the same as if here repeated. Note the general statement about proposals, and estimate in accordance therewith.

1. MATERIALS. Paint shall consist of National White Lead Company's pure white lead, combined with American Linseed Oil Company's pure kettle boiled linseed oil. For sheet metal use priming coat of iron mineral paint in linseed oil.

Filler shall be of Wheeler's or Bridgeport Wood Finishing Company's wood filler. Stains shall be Sherwin William handcraft stains.

Shellac shall be transparent alcohol shellac. Varnish shall be Murphy Brothers' transparent wood finish, interior and exterior.

Enamel shall be two coats of Sherwin Williams' or equal snow white enamel. All enamelled work shall be laid on two coats of Sherwin Williams' "Flat-tone Paint".

NOTE. The Architect will decide upon all colors.

2. MIXING. No mixing shall be done except in the paint room. In this room, should the floor become paint coated, stained or otherwise injured, it shall be taken up and replaced at the cost of the painting contractor. This clause applies also to any floors damaged by the painter.

3. STOPPING, FILLING AND PUTTYING. Give all knots and sap a coat of stopping varnish before priming. Nail holes and imperfections shall be puttied up before painting with putty colored to match the finish.

4. OUTSIDE PAINTING. All outside wood and metal work shall have three coats of paint. On woodwork the paint shall be lead and oil; on metal work one coat of iron mineral with two of lead and oil, sanded with white sand on galvanized iron cornices, where such are specified.

5. OUTSIDE VARNISHING. Entrance doors and outside of frames shall be stained, filled and given three

coats of Murphy Brothers' exterior transparent wood finish.

6. ROOF PAINTING. All tin and metal work upon the roof shall have three coats of iron mineral paint and linseed oil, colored exactly to match the tile or slate.

7. VARNISH FINISH. Where oak is specified or finish it shall be stained, filled and given two coats of varnish and a coat of dead lac of a brand approved by the Architect. Where birch or pine is specified it shall be stained and varnished as above, or shall be painted three coats as below specified. All exposed metal work shall have three coats of paint.

8. SASH. All sash shall be given three coats of white lead and oil.

9. SCHEDULE OF VARNISH, PAINTING AND TINTING:

All interior finish and exterior doors and frames stained and varnished.

Metal work three coats of paint.

GLASS.

10. PLATE GLASS. Entrance and vestibule door lights and transoms shall have plate glass. First story windows facing streets plate glass.

COMMON GLASS. Other windows shall be glazed with AA double thick American glass free from wind or blemish set in the best putty well bedded and tacked and left clean and whole on completion of the work.

OTHER GLASS. Corridor doors and interior windows shall have frosted wire glass.

FINALLY. This contract contemplates and comprises a perfect and complete job of painting, varnishing and glass work, and anything necessary to that result is hereby included the same as if particularly mentioned, described and detailed upon the plans and details. When completed the contractor shall remove all debris, tools, machines and appartus of every sort belonging to this work, leaving the premises free and clear from anything of the kind.

Approved

F. E. Turneaure

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